

Writing and Editing for STEM

Second edition

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Published by Words & Numbers

www.wordsandnumbersediting.co.uk

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First published 2021

Second edition 2023

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Preface

This guide to STEM editing is for the following readers:

- Copy editors, typesetters and proofreaders: This guide should help you to ensure that the text you are working on is correct, consistent and clear.
- Authors: If, as an author, you format your technical content correctly, then it is less likely that an intrusive copy editor will subsequently make incorrect changes that alter the meaning of what you have written.
- Academic referees: This guidance will help you to decide whether the paper you are reviewing is of a sufficient typographic standard for publication.

For any corrections, amendments or suggestions, please email me at jonathan.webley@gmail.com.

1 Introduction

This is a guide to editing scientific, technological, engineering and mathematics (STEM) publications. Publishers have their own standards, so this guide mentions the main ones, but always consult the guidelines for the particular journal or publisher. The most important point, for clarity, is to be consistent and use the same standards throughout an article, thesis, book or book chapter (for brevity, these are referred to as a generic “paper” in these guidelines).

The aim of this work is not to teach science but to show how technical material should be written to ensure clarity. Note that the facts are always the responsibility of the author. If a copy editor or proofreader thinks that something is factually wrong, they should raise an author query.

1.1 Other references

One of the best published guides for STEM authors and editors is the *Publication Manual of the American Psychological Association*.¹

The *Green Book* published by the International Union of Pure and Applied Chemistry (IUPAC) gives comprehensive guidance on formatting STEM material with a focus on chemistry.²

2 General

Academic texts are formal. The readers may not be specialists in the topic of a book or article, and their first language may not be English. There should be no contractions (don’t), idioms, local expressions or other constructions that may hinder the reader’s understanding.

2.1 Fonts

Standard fonts and font sizes should be used where possible. It is better to use a font that accentuates the difference between similar symbols (1 and l, κ and k, 0 and O, etc.).

Also note that most word processing and typesetting systems deliberately use different fonts for maths and text. For example, in L^AT_EX, “first” in italics is *first* and in math mode it is $first$. Similarly, in some font combinations, numbers and other symbols in text mode (μ) are different from those in math mode (μ).

Papers written by Asian authors often use fonts such as SimSun, especially for punctuation. This font must be corrected to the font used for the rest of the paper. Note that glyphs in such fonts often have embedded space, usually after but before for opening parentheses. When the font is converted, this space needs to be added manually.

2.2 Punctuation

- Commas should be upright (also called roman), not italics, unless surrounded by italic text (1, 2, 3, \dots , n).
- Quote marks and apostrophes should be curly not straight (‘...’, “...”).
- In maths, primes are upright and not treated as a superscript (x' , x'').

¹Published by the American Psychological Association, Washington DC.

²International Union of Pure and Applied Chemistry: iupac.org/what-we-do/books/greenbook/

2.3 Tense

Tense depends on the publisher's preferences. Some publishers insist on using present tense, for example, to describe an experiment (the liquid is boiled for 5 min). However, this can lead to ambiguity. If no such restrictions are imposed by the publisher (or author), the use the past tense for actions in the past.

Tense	Use	Examples
Past tense	For events in the past: <ul style="list-style-type: none">• previous research• a description of an experiment• a description of results	Hawking found that black holes evaporate. The liquid was boiled for 5 min. The liquid boiled after 5 min. of heating. The results were not statistically significant. The mean was ...
Present tense	For events true at the time of reading: <ul style="list-style-type: none">• mentioning results• conclusions• general facts	Section 2 describes the methods used. Figure 1 is a photograph of the apparatus. Table 1 shows the mean and standard deviation. The results suggest that ... Blue whales are marine mammals.
Future tense	For events that are yet to happen: <ul style="list-style-type: none">• future work	In future work, the method will be extended to ...

2.4 Active and passive voice

Examples of active voice:

We repeated the experiment five times.
The participants completed the survey.

Example of passive voice:

The experiment was repeated five times.
The survey was completed.

Voice depends on the publisher's preferences. Passive voice is considered bad style, and active voice should be used where possible. However, some publishers proscribe the use of first person pronouns for the authors, making passive voice hard to avoid.

Some authors refer to themselves as "the authors", but in a literature review this can lead to significant ambiguity. If first person pronouns are not proscribed by the publisher or author, then using them can make the text simpler and clearer, and is recommended. For a single author, use "I" and for multiple authors use "we".

Passive voice focuses on the action rather than the actor, so its use is acceptable in the methods section when describing the setting up of an experiment, for example.

2.5 Tense, mood, etc. in mathematics derivations

The following are acceptable, unless the publisher prefers otherwise.

Imperative:

Divide by x to give ...

Past tense with passive voice:

The expression was divided by x to give ...

Past tense with active voice:

We divided the expression by x to give ...

2.6 Mass and count nouns

Mass nouns are used for things that normally cannot be counted (e.g. a substance or quality). Qualities like “happiness” do not have a plural and are not used with an indefinite article. Count nouns are used for things that can be counted (people, atoms).

Mass nouns for substances (butter, salt, DNA) can also act as count nouns:

There were five different salts in the solution.

However, using a plural form can sometimes be ambiguous. For example, “We bought three coffees” could mean “We bought three cups of coffee” or “We bought three types of coffee.” Using phrases such as “types of” or “pieces of” can always resolve any potential ambiguity:

- Cloves of garlic
- Strands of DNA
- Pieces of cheese
- Bottles of wine
- Species of fish
- Lumps of metal

	Mass noun	Count noun
Plural	No	Yes
Amount or number	Amount (of iron)	Number (of atoms)
Determiners	Less/more (wood) Not much/much (ice)	Fewer/more (mice) Few/many (tests)
Quantity	Units 5 kg of butter 750 mL of water	Number 5 eggs

2.7 Capital letters and trade names

As mentioned elsewhere, do not use unnecessary capitals, which are mainly reserved for proper nouns (Euler's number, hydrogen, mouse, Newton's third law, quantum physics).

Trade names – of drugs, materials, instruments, etc. – always have an initial capital. Follow the publisher for use of ©, ® and ™. Specific devices and pieces of equipment are generally referred to as: generic name (product code, manufacturer, location). For example,

Images were recorded with a digital microscope (ABC-123, Acme Microscopes Inc, USA).

The aim is to give sufficient information for the specific piece of equipment to be identified. See also Chapter 9.

Initial capitals are not used for job titles (unless the title precedes a name: Professor Smith) or diseases (unless based on a proper noun: Alzheimer's disease).

2.8 Elegant variation and other aspects of style

The most important advice for any author is that, in general, to aid clarity, short sentences and short noun phrases are preferable.

To avoid repeating some words or phrases, authors often use synonyms or vary the structure. However, in a technical text, this can lead to ambiguity or confusion, especially to someone unfamiliar with the subject or whose first language is not English. Moreover, when similar ideas are expressed in different ways, it can be hard to identify the differences and similarities. Therefore, repeating a structure can aid the reader, who is not interested in the literary merits of the work. The overriding principle for STEM is that the meaning has to be clear and not obscured by elegant variation.

For example, there is nothing wrong with the repetition in these figure captions:

Fig. 1. Current versus voltage for a copper wire, 1 mm thick, at room temperature and atmospheric pressure where $L = 1$ cm.

Fig. 2. Current versus voltage for a copper wire, 1 mm thick, at room temperature and atmospheric pressure where $L = 2$ cm.

Fig. 3. Current versus voltage for a copper wire, 1 mm thick, at room temperature and atmospheric pressure where $L = 3$ cm.

Varying the structure would make it harder to comprehend what has changed in the different experiments.

To avoid repetition, the following approach is also acceptable:

Fig. 1. Current versus voltage for a copper wire, 1 mm thick, at room temperature and atmospheric pressure where $L = 1$ cm.

Fig. 2. Current versus voltage for the same conditions in Fig. 1 but where $L = 2$ cm.

Fig. 3. Current versus voltage for the same conditions in Fig. 1 but where $L = 3$ cm.

3 Figures and tables

The final position of tables and figures (floats) is not known until the typesetting stage, as it depends on paper sizes, margins, fonts, etc. Therefore, authors and copy editors should not spend too much time on positioning them, for example using anchors in MS Word. Moreover, they may appear before or after any

mention in the text, so should not be referred to with words such a “below” or “above” but by number (see Table IV; see Fig. 2).

There are many rules for captions. For example, some publishers do not allow a final period whereas the final period is mandatory for others. There is generally no need for a caption to repeat large portions of the text. Follow the publisher and aim for consistency.

3.1 Figures

“Figure” and “Figures” are often abbreviated as “Fig” (or “Fig.”) and “Figs” (or “Figs.”), but the full word is commonly used at the start of a sentence, depending on the publisher’s preferences. The number should be on the same line as “Fig.”, etc.

The caption is usually placed underneath the figure.

Here is a sample figure (not treated as a float):



Figure 1: A hedgehog.

3.2 Tables

“Table” and “Tables” are not usually abbreviated. The number should be on the same line as “Table”. There are many ways of formatting tables, with no commonly accepted standard. A common choice is not to use vertical rules and to use horizontal rules at the top and bottom and to separate the heading. This is the standard used in this guide.

The caption is usually placed above the table.

Here is an example (not treated as a float):

Table 1: Paper dimensions.

Size	Width, w (mm)	Length, l (mm)
A3	297	420
A4	210	297
...		

The units are sometimes placed on a separate line or separated by a solidus (Width, w /mm). Blank cells may contain a dash.

4 Numbers

Publishers usually specify some rule, such as words are used for numbers one to ten and digits for numbers over 11. They may prefer that styles are not mixed in one sentence:

There were 4 blackbirds and 20 starlings.

In STEM, numbers are always used with units (4 m, 3 years).

Usually a sentence does not start with a number in numerals, but this depends on the publisher's preference.

It is better not to have two consecutive numbers written in numerals (~~11 2-cm lines~~) by spelling out the first of the numbers (eleven 2-cm lines).

Larger numbers with five or more digits are written with either a comma (60,000,000) or a thin space (60 000 000) every three digits. Four-digit numbers are usually written with neither (6000). Numbers with many decimal places may also use a thin space for the decimals (3.14159265359 or 3.141 592 653 59). Note that Europeans use a decimal comma (3,141) and points to separate thousands (60.000,000), which should be changed to a decimal point and commas or spaces, respectively.

Numbers are sometimes expressed in scientific notation (1.234×10^{-5}). In computer code and on calculators, the 10 becomes an E (1.234E-5). This notation should be changed to standard scientific notation with a power of 10. Such changes can be done by a copy editor or left to the author via a query.

Numbers in tables are aligned right or aligned on the decimal point, partly depending on the aesthetics. To ensure alignment, four-digit numbers may have a comma or thin space like larger numbers.

Number ranges are best expressed with an en dash (4–10) but a hyphen may be acceptable to a publisher (4-10). The dash should be closed up (~~4-10~~). Asian authors sometimes use a tilde (4~10), but this should be changed to one of the other forms. When used with a minus, “to” is best (–1 to 1; –2 to –1).

4.1 Precision

Trailing zeros are acceptable after the decimal point (1.000), because the zeros indicate the precision of the measurement or result. Note that some tools, like Excel, remove final zeros from decimal fractions (e.g., 1.000 \rightarrow 1). Since the number of decimal places is related to the precision, if it is suspected that this has happened, query the author.

However, authors sometimes quote too many decimal places (or significant figures). Examples should be raised as an author query. For example, if 7 people out of 90 test positive, then the percentage could be

calculated as $7/90 \times 100 = 7.7778\%$. That 0.0008 represents 8 in 1,000,000, which is clearly way beyond the precision of the test. Similar issues can be seen with lengths, weights, etc.

5 Units

Système International (SI) units are always preferred and mandatory for some publishers. Equivalent values in units from other measurement systems can be given in parentheses if necessary. The symbols for the SI units are internationally agreed and should not be changed. Units should be consistent within a paper, and a paper should not, in general, quote a mix of, for example, degrees and radians. The exception is units of time, since “seconds”, “minutes”, “hours”, etc. are all acceptable in the same document. More information about SI units can be found from NIST.³

- Units are always upright.
 - Four metres is 4 m whereas $4m$ means 4 times the variable m .
- Percentage and degree signs are usually closed up to the number (10% and 10°) but temperature degrees can be either (10°C or $10\text{ }^\circ\text{C}$).
- The symbol for degrees ($^\circ$) is not a superscript “o” ($^\circ$).
- Arcminutes and arcseconds are abbreviated with primes and closed up ($10^\circ 5' 10''$).
- All other units are separated from the number. Units are separated from the number and from each other with a full space (4 N m), a thin space (4 N m) or, occasionally, from each other with a centre dot (4 N·m), depending on the publisher’s preference.
 - 4 ms^{-1} means 4 per millisecond whereas 4 m s^{-1} means 4 metres per second.
 - K for kelvin is separated from the number (10 K).
- Abbreviations for units are always singular (4 km) whereas the full word agrees with the number (4 kilometres):
 - “Kilometres” is abbreviated km not Km or kms.
 - Similarly, “kilogrammes” (equivalently, kilograms) is kg.
- Abbreviations are case sensitive (mm = millimetres and Mm = megametres) whereas the full word, being a common noun, is lower case (newtons), except at the start of a sentence.
 - “Litres” can be abbreviated as L or l, but usage needs to be consistent.
- It is clearest to give the name of the unit, in the singular, when it is hyphenated (41-year-old man, 6-metre rod).
- If a distinction needs to be given between AC and DC for voltage, use parentheses: 4 V (DC).

Some units are named after notable scientists. These are always written lower case and are plural if necessary (4 newtons = 4 N, 4 kilonewtons = 4 kN). Here are the main ones:

ampere	hertz	siemens
becquerel	joule	sievert
coulomb	kelvin	tesla
dalton	neper	volt
farad	newton	watt
gauss (obsolete)	ohm	weber
gray	pascal	
henry	roentgen or röntgen (obsolete)	

³physics.nist.gov/cuu/Units/index.html

Celsius and Fahrenheit are always written with an initial capital.

Ton refers to the imperial unit. The metric version is a metric ton or tonne (symbol t), which is equivalent to a megagram (1 Mg). If there is any doubt, query the author.

When used as a variable (for example, a mean, $\mu = \dots$), μ is italic but when used for micro- in SI units, it should be upright (5 μm). If u is used for micro-, it should be changed to μ .

Units involving division can be written in two ways: m/s or m s^{-1} . Units should not be written with two solidi ($\text{W/m}^2/\text{K}$) as this is slightly ambiguous. They are usually changed to use negative superscripts ($\text{W m}^{-2} \text{K}^{-1}$) or can be written with parentheses [$\text{W}/(\text{m}^2 \text{K})$].

Copy editors should ensure that the number and all parts of the units are on the same line.

In tables, units are usually placed as part of the column head (but only if they are the same throughout the column):

Distance [m]	Speed [m/s]	Time
5	5	1 s
1000	1	16.67 h

Quantities of chemicals in a mixture or alloy may be given as the percentage by weight or weight percentage (wt.% or wt%) or percentage by number of atoms or atomic percentage (at.% or at%), points being more common in the acronyms in US English.

6 Mathematics

It is not the copy editor's job to check the mathematics, though simple errors should be raised as queries. The copy editor is often responsible for formatting, as follows, but care should be taken not to change the meaning.

6.1 Tools

The first issue is how to get mathematics into a document. Many publishers insist that STEM documents are written in \LaTeX . This guide was written in \LaTeX , so its advantages should be obvious. \LaTeX supports a huge range of symbols and formats.

There are many free online guides, tutorials, fora and tools for \LaTeX . Here are some notable ones:

- \TeX User Group (TUG), *Getting started with \TeX , \LaTeX , and friends*, www.tug.org/begin.html
- StackExchange for \TeX , tex.stackexchange.com/
- Overleaf, an online collaborative \LaTeX editor, www.overleaf.com/
- Wikibook on \LaTeX , en.wikibooks.org/wiki/LaTeX
- Michael Downes, updated by Barbara Beeton, *Short Math Guide for \LaTeX* , tug.ctan.org/info/short-math-guide/short-math-guide.pdf
- Scott Pakin, *The Comprehensive \LaTeX Symbol List*, tug.ctan.org/info/symbols/comprehensive/symbols-a4.pdf

The main disadvantages of \LaTeX are that (1) it is a form of coding, though WYSIWYG editors are available, such as Overleaf⁴ and (2) it takes effort to get started.

The only book I would recommend is *The LaTeX Companion* by Frank Mittelbach, Michel Goossens and others. The fourth edition is due in 2023. It is not, however, a guide for beginners but rather a reference.

For those using word processing software, such as MS Word, there are a number of equation editors. In MS Word, the built-in equation editor is accessible through `Insert > Equation`. This is a somewhat basic tool, with nowhere near the functionality of \LaTeX . A popular and more comprehensive proprietary add-on is MathType.⁵

MS Word supports many symbols used in mathematics. For example, typing `\times` produces a multiplication sign. Further details of how to type mathematics into word processing software can be found in the manufacturer’s websites.

6.2 Italics

The rules for what is italic and what is upright are described under the various headings below. These rules follow even for a block of text in italics:

Equation (2) can be written as $f(x) = 2 \tan(\theta)$.

6.3 Writing mathematics

Mathematics can be in-line or displayed. In-line means that the maths is embedded within a paragraph:

Altogether, $n/2$ of the boys wore a coat. . .

In in-line maths, fractions are written on a single line with a solidus ($1/2$) or as a small glyph ($\frac{1}{2}$).

Displayed means that the maths is on a separate line, so that fractions are on two lines:

$$\frac{1}{2} = \frac{1}{4} + \frac{1}{4}$$

Displayed is always used for complex expressions.

Equations may be numbered:

$$F = ma \tag{1}$$

The numbering is used to refer to the equation: “see Eq. (1)”, “see Equation (1)” or “see (1)”, depending on the publisher’s preference.

Long expressions are broken, usually before an operator, so that they do not obtrude into either margin:

$$a = x - 2x^{-2} + 3x^3 - 4x^{-4} + 5x^5 - 6x^{-6} + 7x^7 - 8x^{-8} + 9x^9 - 10x^{-10} + 11x^{11} - 12x^{-12} + 13x^{13} \\ - 14x^{-14} + 15x^{15} - 16x^{-16} + 17x^{17} - 18x^{-18}$$

The operator at the line break is not repeated on both lines.

Primes are straight, upright and not treated as a superscript (F' , F'' but not F^2).

⁴www.overleaf.com

⁵www.wiris.com/en/mathtype/

6.4 Expressions and functions

Expressions are things like $2ax$ or mc^2 . Numbers are always upright, whereas letters are italics. Words may be either upright or italics:

$$\begin{aligned} \text{Voltage} &= \text{Current} \times \text{Resistance} \\ \textit{Voltage} &= \textit{Current} \times \textit{Resistance} \end{aligned}$$

Standard mathematical functions are always written upright and lower case, with a space before and after:

$$y = a \cos \theta \sin^2 \theta + 3.14 \log_2 10$$

If f , g , etc. are used for a generic function, they are italics [$f(x)$, $g(y)$]. Here is a list of common standard functions (there are many others):

arccos	cosh	grad	sec
arcsin	cot or cotan	ln	sech
arctan	coth	log	sin
arg max or argmax	curl	norm	sinh
cos	det	max	tan
cosec or csc	div	min	tanh
cosech or csch	exp	mod	

Where alternatives are given, one or other version should be used consistently.

Some functions are treated as variables, so may be either upright or italics:

E (expectation) Po (Poisson distribution)
P (probability)

Exponentials may be raised to Euler's number, e . This is either written upright (e^x) or in italics (e^x). Complicated expressions may be better written using the function \exp :

$$y = \exp\left(\frac{a + b + c + d}{z^2/2}\right)$$

Fractions in an exponent are written with a solidus:

$$y = e^{1/2} + 5^{-2/3}$$

Other physical constants, such as the Planck constant h and the Faraday constant F , are treated as standard maths variables and written in italics.

Like Euler's number, $i = \sqrt{-1}$ can be written upright (i) or italics (i). Use the same convention used for Euler's number (both upright or both italics).

Similarly, T for transpose can be written upright or italics, so be consistent with e and i :

$$\begin{bmatrix} 1 & 2 & 3 \end{bmatrix}^T \quad \text{or} \quad \begin{bmatrix} 1 & 2 & 3 \end{bmatrix}^T$$

English words before or between equations (and, if, or) are always upright.

6.5 Arithmetic, relational and other operators

Arithmetic operators are symbols such $+$, $-$, \times and $/$. Relational operators compare two expressions, and include symbols such as $=$, \neq , $<$, \leq , \ll , $>$, \geq , \gg and \approx . Set operators include \cup , \in and \subset .

- Operators are upright (though, an italic version is not usually available in a font).
- In expressions, there is a space either side:

$$y = ax^2 + bx(2 \times 4)/2$$

- An asterisk ($*$) should not be used for multiplication, other than in software. Asterisks may, however, mean something other than multiplication (such as convolution). If in doubt, query the author.
- $<>$ or $!=$ (both meaning not equals) should be replaced with \neq , except in computer code.
- A centre dot (\cdot) may be allowed by a publisher for multiplication, but note that centre dots are used specifically for the scalar product of vectors.
- The minus sign ($-$) is different from a hyphen ($-$), en dash ($-$) or en rule ($---$). Note the difference between a range ($1-5 = 1$ to 5) and subtraction ($1 - 5 = -4$).
- When used as a unary operator for negation, the minus sign is closed up to the number or symbol (-1 , $-a$, $-\sin \theta$). The same applies to other operators such as \pm or $+$ (± 1 , $+1$).
- When used with only one term, relational operators are closed up to the term (<4).
- The division sign (\div) is rarely used, other than in school maths.

6.6 Subscripts and superscripts

Upright is preferred for words and abbreviations of words (P_{\max} or P_{max} , P^{\max} or P^{max}). Italics is always used for single-letter variables (P_i or P^i , where $i = 1, 2, 3$). Italics or upright can be used for single-letter abbreviations (P_o or P_o , P^o or P^o , the output pressure).

6.7 List indices

There are three main conventions for referring to numbered items in a list:

1. Without a hyphen: i th, n th (preferred)
2. With a hyphen: i -th, n -th
3. With an apostrophe: i 'th, n 'th

6.8 Ellipses

An ellipsis in maths is used to indicate the continuation of a pattern. There is a space before an ellipsis in a sequence and following punctuation is closed up:

$$i = 1, 2, 3, \dots$$
$$i = 1, 2, 3, \dots, n$$

Where an ellipsis is used to indicate missing letters in a string, it is closed up:

$$ABC \dots XYZ$$

An ellipsis is raised between operators:

$$S_n = 1 + 2 + \dots + n$$

6.9 Fences

The correct use of fences makes the mathematics clearer whereas incorrect use can obscure the meaning.

The usual sequence is $\{[()]\}$ but note that the symbols can mean different things depending on the context, so the best advice is to follow the author and raise a query if there is some doubt. Fences usually come in pairs:

$$y = \{[(1 + 2) + 3] + 4\}$$

Raise a query or fix if there is an obvious mismatch:

$$\begin{aligned}y &= (1 + 2 \\y &= [(1 + 2) + 3]\end{aligned}$$

but beware that a mismatch is often deliberate and should not be fixed:

$$\begin{aligned}y &= \begin{cases} 1, & \text{if } a < 2, \\ 2, & \text{if } a \geq 2 \end{cases} \\a &\in [0, 3) \quad \text{or} \quad a \in [0, 3[\\b &= z|_1^2 \\ \phi &= \langle a | \end{aligned}$$

Fences should be sized appropriately:

$$y = 2 \left(\frac{dx}{dt} \right)$$

Fences are upright in math ($f(x)$).

Less than ($<$) and greater than ($>$) are sometimes used incorrectly ($\langle x \rangle$) as angle brackets ($\langle x \rangle$).

6.10 Calculus

For some publishers, the d in differentiation and integration is considered to be a function and thus, should be written upright:

$$y = \int f(x) dx, \quad \frac{dy}{dx} = x^2, \quad \frac{d^2y}{dx^2} = 2x$$

Otherwise, it is italic:

$$y = \int f(x) dx, \quad \frac{dy}{dx} = x^2, \quad \frac{d^2y}{dx^2} = 2x$$

In integration, there is commonly a space before the d.

Double integral signs, triple integral signs, etc. are closely spaced:

$$y = \iint f(x) dx, \quad y = \iiint f(x) dx$$

6.11 Points, angles, vectors and matrices

In geometry, points are usually italic (A , $\triangle ABC$). Angles can be represented in various ways (A , \hat{A} , $\angle ABC$, $\hat{A}BC$), so consistency is good. Points are usually upper case whereas lengths are usually lower case (a).

There are several conventions for vectors (v , \bar{v} , \vec{v} , \mathbf{v}), matrices (A , \mathbf{A}), tensors, etc. Ensure consistency.

6.12 Alignment

Equations are usually centre aligned to the page:

$$E = mc^2$$

A sequence of equations is aligned on =, <, ≈, etc.:

$$\begin{aligned}a &= 1 \\ab &\neq 1 + 2 \\abc &\geq 1 + 2 + 3 \\abcd &\approx 1 + 2 + 3 + 4\end{aligned}$$

Sometimes, equations are aligned left with an indent:

$$\begin{aligned}y &= mx + c \\y^3 &= ax^2 + bx + c\end{aligned}$$

6.13 Punctuating equations

In-line maths is always punctuated as usual:

The number of participants was n . The mean was calculated as $\mu = \sum x_i/n$.

Displayed maths is punctuated per the publisher's requirements.

The voltage is

$$V = IR,$$

where

$$R = 42 \Omega.$$

Some publishers prefer not to use punctuation:

The voltage is

$$V = IR$$

where

$$R = 42 \Omega$$

Punctuation marks should be upright (a, b, c), not italics (~~a, b, c~~), unless part of a larger text in italics (*Subtraction, for example, is the inverse of addition*).

When the name of a variable and its symbol are mentioned in text, they may, or may not, be surrounded by commas:

The average μ was calculated as...

The average, μ , was calculated as...

This is regardless of whether the usage is defining or not. Without commas is recommended.

Equations and other expressions are often introduced with a colon, whether in-line or displayed. The colon is used in the same way that it is used to introduce a list. This means it is not used after a verb such as "is":

The logistic equation is

$$\frac{dP}{dt} = rP \left(1 - \frac{P}{K}\right)$$

It is used after an expression such as “as follows” or after a complete sentence:

The logistic equation can be written as follows:

$$\frac{dP}{dt} = rP \left(1 - \frac{P}{K}\right)$$

The logistic equation is commonly used:

$$\frac{dP}{dt} = rP \left(1 - \frac{P}{K}\right)$$

6.14 *p*-values and engineering numbers

In statistics, a *p*-value is a probability, so the *p* is a maths expression and should be italics. Here, “value” is somewhat redundant, so the following are equivalent and both are acceptable, depending on the context:

The *p*-value is 0.05.

$$p = 0.05$$

The same applies to other “values”.

Symbols for numbers like the Reynolds number (Re or *Re*), Strouhal number (St or *St*) and Prandtl number (Pr or *Pr*) can be upright or italic, depending on the publisher’s preference.

7 Astronomy

7.1 Latitude and longitude

These are written in one of the following ways:

- Closed up: 55°51′51.2604″ N and 4°15′6.5016″ W
- Spaced out: 55° 51′ 51.2604″ N and 4° 15′ 6.5016″ W
- Decimal fractions: (55.864239, -4.251806)

7.2 Right ascension and declination

These are usually written as follows:

- RA 2^h 41^m 39^s, Dec +89° 15′ 51″

with variations as above.

7.3 Astronomical objects

Planets (Mercury, Venus), stars (Alpha Centauri, Castor, Polaris, Pollux, Sirius) and other astronomical objects (Pluto, Milky Way) generally have initial capitals, except for common English words (Halley’s comet, Kuiper belt, Orion’s belt). Star names may also be written using a Greek letter and the genitive

form of the constellation (α Centauri). The signs of the zodiac are all constellations (Aries, Taurus). The common names of constellations have an initial capital (Great Bear, Plough). Earth, Sun and Moon usually have capitals in an astronomical context. “Moon” may refer to the moon of another planet (Europa, Io), in which case it is lower case.

There are symbols for planets, signs of the zodiac and other objects:

Planets		Signs of the zodiac		Others
Mercury	♿	Aries	♈	Sun ☉
Venus	♀	Taurus	♉	Pluto ♇
Earth	♁	Gemini	♊	
Mars	♂	Cancer	♋	
Jupiter	♃	Leo	♌	
Saturn	♄	Virgo	♍	
Uranus	♅	Libra	♎	
Neptune	♆	Scorpio	♏	
		Sagittarius	♐	
		Capricorn	♑	
		Aquarius	♒	
		Pisces	♓	

The International Astronomical Union has standardised the names of astronomical objects.⁶

For naming conventions for spacecraft and satellites, see Chapter 13.

8 Biology

Common names are generally upright and lower case (cat, porcupine, cactus) even if long (lesser black-backed gull). However, common names are sometimes used with initial capitals to avoid confusion. For example, a Red Panda refers to a panda of the species *Ailurus fulgens* rather than a panda that is red (although, it is somewhat red in colour).

The scientific names of animals are standardised by the International Commission of Zoological Nomenclature,⁷ the names of plants, algae and fungi by the International Association for Plant Taxonomy⁸ and cultivated plants by the International Society for Horticultural Science.⁹

The scientific or binomial name for species has two parts, the genus and the species. Both are always italics and the genus always has an initial capital (*Homo sapiens*). The genus (*Homo*) can be used on its own but the species never is. After the first use (*Escherichia coli*), the genus may be abbreviated to an initial, if not ambiguous (*E. coli*). The abbreviation “spp.” after a genus means all species in that genus (*Homo* spp.).

A subspecies has an additional name after the species name (*Homo sapiens neanderthalensis*). Below subspecies, plants may have a variety (*Escobaria vivipara* var. *arizonica*) or cultivar, given in upright

⁶Naming of Astronomical Objects: www.iau.org/public/themes/naming

⁷International Commission of Zoological Nomenclature: www.iczn.org

⁸International Association for Plant Taxonomy: www.iapt-taxon.org/nomen/main.php

⁹International Society for Horticultural Science: www.ishs.org/news/icncp-international-code-nomenclature-cultivated-plants-9th-edition

(*Rosa* “Fourth of July”, *Rosa banksiae* “Lutea”), sometimes with “cv.” (*Rosa* cv. “Fourth of July”). Hybrids are marked with a cross (*E. africanus asinus* ♂ × *E. ferus caballus* ♀).

A new genus or species is indicated with “gen. nov.” or “sp. nov.”, respectively (*Akkermansia muciniphila* gen. nov., sp. nov.). When a species is assigned to a different existing genus, it is called a new combination (*Klebsiella granulomatis* comb. nov.).

The name of the person who first classified the organism (the authority) is sometimes placed at the end of the species name or genus. These are upright and have an initial capital (*Homo sapiens* Linnaeus). In botany, they are often abbreviated (*Amaranthus retroflexus* L.). The year of publication may also be specified (*Homo sapiens* Linnaeus, 1758). If the genus is subsequently changed by another authority, the name of the original authority is placed in parentheses [*Hyacinthoides italica* (L.)] and the new authority may be added [*Hyacinthoides italica* (L.) Rothm.].

Sometimes, the genus is used as a common name, in which case it is lower case and upright (dahlia, listeria infection, tyrannosaurus). Correct usage depends on context. Here are some examples of genera also used as common names:

Bacteria	Dinosaurs	Mammals	Plants	Yeast
<i>Listeria</i>	<i>Brontosaurus</i>	<i>Hyaena</i>	<i>Dahlia</i>	<i>Candida</i>
<i>Salmonella</i>	<i>Diplodocus</i>		<i>Primula</i>	
<i>Staphylococcus</i>	<i>Stegosaurus</i>		<i>Rhododendron</i>	
<i>Streptococcus</i>	<i>Triceratops</i>			
	<i>Tyrannosaurus</i>			

Often, the common name of a virus or group of viruses is used, which is upright and lower case (coronavirus, human immunodeficiency virus, Epstein–Barr virus, herpes simplex virus, influenza virus, norovirus, retrovirus). They are often referred to by an acronym (EBV, HIV).

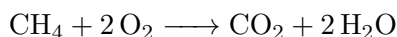
Above genus, organisms are classified into various groups (family, order, class, phylum), which are proper nouns so upright with an initial capital (Crustacea, Hominidae, Insecta, Mollusca).

9 Chemistry and pharmacology

The names of elements and compounds are lower case (hydrogen, polypropylene), unless they are a trade name (Inconel, Teflon). Use “sulfur”, “sulfide”, etc. rather than “sulphur”, “sulphide”, etc. in chemistry and most other science contexts. As in general mathematics, variables are written in italics.

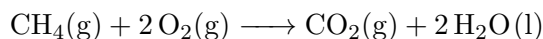
Element symbols are written upright in mixed case (H, He, Li). Compounds are written with subscripts (CO₂, not ~~CO2~~), which may include a variable (NO_x and SO_x, not ~~NOX~~ or ~~SOX~~). CO₂ and NO_x are acceptable in non-technical material. Ions are written with superscripts (Fe⁺, Fe⁺⁺, Fe²⁺ or Na⁻, Na⁻⁻, Na²⁻). Alloys are written like this: Ti6Al4V or Ti–6Al–4V. Names of compounds may also include a variable (*N,N*-dimethylaniline). An asterisk is used to indicate that the bonding electrons are in an excited state (F^{*}).

Chemical reactions are usually written with an arrow pointing from the reactants to the products:

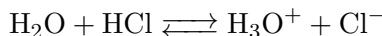


Copy editors should check that the number of atoms of each element and the total electric charge balance on each side.

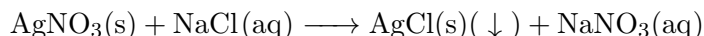
Symbols can be used to indicate a solid (s), liquid (l), gas (g) or something in an aqueous solution (aq):



Reactions may go in either direction:



An arrow pointing upwards (\uparrow) represents the gaseous product of a chemical reaction. An arrow pointing downwards (\downarrow) represents a precipitate of a chemical reaction:



Isotopes are written in different ways: uranium-235, ^{235}U or $^{235}_{92}\text{U}$. Forms such as U-235 should be changed to one of the other forms.

Single bonds are written with an en dash (C–C) and double bonds with an equals sign (C=C).

Follow IUPAC's guidelines for the names of compounds.¹⁰

Medicines have a generic name, which is always lower case (aspirin, paracetamol, valsartan). When marketed, they are given a trade name, which has initial capitals (Hedex, Viagra). There may be a different trade name in each country or for each formulation. The generic name is preferred unless there is a reason to use the trade name. See also Section 2.7.

On food products, over-the-counter medicines, herbal formulations, cosmetics¹¹ etc., the list of ingredients is given upright with initial capitals (Aqua, Demerara Sugar, Paprika, Ground Mustard Seed) or without initial capitals (Aqua, demerara sugar, paprika, ground mustard seed), even though in other contexts they would be treated differently. For example, *Aloe vera* is the scientific name of a species of plant, but may appear as "Aloe Vera". Follow the manufacturer, who will want labels standardised across their product range.

The word "species" refers to atoms, molecules, ions and other particles.

9.1 Electron configuration

Shells are denoted with upper-case upright letters: K, L, M, N, etc.

Subshells are denoted with lower-case upright letters: s, p, d and f.

Orbitals have an integer for the shell and a subshell letter: 1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d, 7p, etc.

The number of electrons in an orbital is given with a superscript: $1s^2$.

These can be combined to give the electronic configuration of an element, which can be abbreviated by using noble gases:

¹⁰International Union of Pure and Applied Chemistry: iupac.org/what-we-do/nomenclature/

¹¹International Nomenclature of Cosmetic Ingredients: cosmetics.specialchem.com/inci-names

Hydrogen	$1s^1$		1 electron
Helium	$1s^2$		2 electrons
Lithium	$1s^2 2s^1$	$[\text{He}] 2s^1$	3 electrons
Beryllium	$1s^2 2s^2$	$[\text{He}] 2s^2$	4 electrons
...			
Phosphorus	$1s^2 2s^2 2p^6 3s^2 3p^3$	$[\text{Ne}] 3s^2 3p^3$	15 electrons
...			

9.2 Spin orbit splitting in XPS

Peaks in XPS use the nomenclature: nl or nl_j , where

- n is the principal quantum number (an integer)
- l is the angular momentum quantum number (a letter such as s, p, d or f)
- j relates to the spin (a fraction such 1/2 or 3/2)

Typical values: 1s, 2p, $2p_{1/2}$, $2p_{3/2}$, $3d_{5/2}$

Values may be preceded by the element: As $3d_{3/2}$, Cr $2p_{3/2}$

10 Geology

Names of aeons (Phanerozoic), eras (Paleozoic) and periods (Jurassic, Cambrian) are proper nouns and should start with a capital letter. They are also used as proper adjectives (Phanerozoic Aeon, Paleozoic Era, Jurassic Period). “Eon” is used in US English. Names are standardised by the International Commission on Stratigraphy, a subcommittee of the International Union of Geological Sciences.¹²

Geological structures referring to specific places, such as tectonic plates (Eurasian Plate), basins (Western Canada Sedimentary Basin), formations (Kayenta Formation), and faults (San Andreas Fault), are proper nouns and should start with a capital letter.

Names of rocks (coal, gneiss, granite, limestone, sandstone) and minerals (jade, mica, quartz) are common nouns.

Names of fossils are scientific names. See Chapter 8.

11 Meteorology

Named hurricanes, cyclones, storms, etc. have initial capitals (Hurricane Katrina, Storm Francis). They are referred as “it”, regardless of whether the name is male or female.

¹²International Commission on Stratigraphy: stratigraphy.org/chart

12 Software

Each programming language uses its own set of notation, so the examples are typical forms of the syntax used.

Symbol	Meaning	Example	
++	add 1	add 1 to a	$a++$
--	subtract 1	subtract 1 from a	$a--$
+=	add	add 5 to a	$a+=5$
-=	subtract	subtract 5 from a	$a-=5$
=	multiply	multiply a by 5	$a=5$
/=	divide	divide a by 5	$a/=5$
*	multiplication	2×3	$2*3$
^ or **	exponent	2^3	2^3 or $2**3$
:=	assignment	set a equal to 1	$a:=1$
==	is equal to (in a condition)	if $a = 1$ then...	if $a==1$ then...
<>	is not equal to (in a condition)	if $a \neq 1$ then...	if $a<>1$ then...
!=	is not equal to (in a condition)	if $a \neq 1$ then...	if $a!=1$ then...
&&	logical and (in a condition)	if $a = 1$ and $b = 2$ then...	if $a==1 \ \&\& \ b==2$ then...
	logical or (in a condition)	if $a = 1$ or $b = 2$ then...	if $a==1 \ \ b==2$ then...
E	power of 10	2.123×10^5	$2.123E05$

Here is an example of an algorithm or pseudocode:

```
1: Set  $n = 100$ 
2: Initialise  $k = 0, i = 0$ 
3: while  $i < n$  do
4:   if  $k = 0$  then
5:      $k = \dots$ 
6:   else
7:      $k = \dots$ 
8:   end if
9:   Increment  $i$ 
10: end while
```

Algorithm 1: Pseudocode to calculate k .

13 Vehicles

- Types of vehicle: Upright and lower case (U-boat, space shuttle).

- Models of vehicle from a manufacturer: Upright with initial capitals (Model T Ford); these are trade names.
- Specific vehicles: Italics with initial capitals (*Cutty Sark*); some publishers may prefer to use upright for these.
- Prefixes for ships (HMS, RMS, SS, USS) are always upright (USS *Enterprise*).
- Ship classes named after a type ship: The ship name is italics (*Vanguard*-class submarine).

Type	Model	Specific
Aircraft	Boeing 747, Concorde, Spitfire	<i>Spruce Goose, Wright Flyer</i>
Cars	Ford Mustang, Rolls-Royce Phantom	<i>Herbie</i>
Satellites, spacecraft, rovers, etc.	Falcon 1, Mars Exploration Rover, Saturn V	<i>Apollo 11, Discovery, International Space Station, Mars Global Surveyor, Sputnik 1, USS Enterprise</i>
Ships, boats	Sunseeker Superhawk 43, Topper	<i>HMS Victory, RMS Titanic</i>
Trains	InterCity 125	<i>Flying Scotsman</i>

Aim for consistency.

14 Main parts of a STEM article

This chapter deals specifically with an article or thesis, rather than a book or book chapter.

14.1 Abstract

An abstract must be concise and factual. It is often the only part of the article read by other researchers searching for relevant articles. An abstract should state briefly the purpose of the research, the principal results and any major conclusions. Some publishers give a maximum number of words for an abstract. Abstracts are often presented separately from the article, so they must be self-contained. Any abbreviations used in the abstract must be defined separately in it. References are best avoided. Generally, abstracts do not have tables, figures or displayed equations.

14.2 Keywords

Keywords are used when searching for relevant articles. Thus, for generality, they are best written in American spelling. General and plural terms and multiple concepts should be avoided, so for example, they should not include “and” or “of”. Only abbreviations firmly established in the field should be used.

14.3 Main text

This is often structured with numbered sections as follows:

1. Introduction: Why was this research done? This section may instead be called background. It may include a literature review or that may be in a subsequent section.
2. Material and Methods: What was done?
3. Results: What was found?

4. Discussion: What do the results mean? If multiple experiments are performed, it can be more appropriate to include the discussion for each following the relevant results in a combined results and discussion section
5. Conclusions: What does it all mean in short? Also, summarise the main results.

Some publishers insist on such a structure, others are more flexible.

Results and discussion can often be combined. For a paper describing multiple experiments, it may be structured as follows:

1. Introduction
2. Material and Methods
3. Results and Discussion of Experiment 1
4. Results and Discussion of Experiment 2
5. ...
6. Conclusions

14.4 Declarations

These follow the conclusions and depend on the publisher and journal. They include sections on ethics, conflicts of interest, funding, data sources, etc.

14.5 Reference citations

Here are some common formats for references.

Superscript numbers, outside punctuation:

In the classical theory, black holes can absorb but not emit particles.¹ Hawking asserted¹ that “quantum mechanical effects cause black holes to create and emit particles”. According to Ref. 1, “this thermal emission leads to a slow decrease in the mass of the black hole.”

¹Hawking, Stephen W. (1975) “Particle creation by black holes” in *Euclidean Quantum Gravity*. World Scientific, Singapore. pp. 167–188.

Numbers in parentheses, within punctuation:

In the classical theory, black holes can absorb but not emit particles [1]. Hawking asserted [1] that “quantum mechanical effects cause black holes to create and emit particles”. According to Ref. [1], “this thermal emission leads to a slow decrease in the mass of the black hole.”

[1] Hawking, Stephen W. (1975) “Particle creation by black holes” in *Euclidean Quantum Gravity*. World Scientific, Singapore. pp. 167–188.

Author-year:

In the classical theory, black holes can absorb but not emit particles (Hawking, 1975). Hawking (1975) asserted that “quantum mechanical effects cause black holes to create and emit particles”.

Hawking, Stephen W. (1975) “Particle creation by black holes” in *Euclidean Quantum Gravity*. World Scientific, Singapore. pp. 167–188.

Publishers usually provide comprehensive details of formatting requirements for references. References that appear to be wrong, such as missing details, can be checked with Google Scholar,¹³ which also provides a BibTeX format suitable for L^AT_EX. The University of British Columbia maintains a fairly comprehensive list of STEM journal abbreviations.¹⁴

A common standard is that journal names, book titles and names of proceedings are italics.

¹³scholar.google.com/

¹⁴woodward.library.ubc.ca/research-help/journal-abbreviations/